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ORIGINAL

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PROVISIONAL SPECIFICATION FOR THE INVENTION ENTITLED:

An Apparatus for Supplying Breathable Gas

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This invention is best described in the following statement:

AN APPARATUS FOR SUPPLYING BREATHABLE GAS

FIELD OF THE INVENTION

The present invention relates to an apparatus for supplying breathable gas.

The invention has been developed primarily for use in Continuous Positive Airway Pressure (CPAP) treatment of, for example, Obstructive Sleep Apnea (OSA) and other ventilatory assistance treatments such as Non Invasive Positive Pressure Ventilation (NIPPV) and will be described hereinafter with reference to this application. However, it will be appreciated that the invention is not limited to these particular uses.

BACKGROUND OF THE INVENTION

CPAP treatment is a common ameliorative treatment for breathing disorders including OSA. CPAP treatment, as described in US Patent No. 4,944,310, provides pressurised air or other breathable gas to the entrance of a patient's airways at a pressure elevated above atmospheric pressure, typically in the range 4-20 cm H_2O.

It is also known for the level of treatment pressure to vary from breath to breath in accordance with patient need, that form of CPAP being known as automatically adjusting nasal CPAP treatment, as described in US Patent No. 5,245,995.

NIPPV is another form of treatment for breathing disorders which can involve a relatively higher pressure of gas being provided in the patient mask during the inspiratory phase of respiration and a relatively lower pressure or atmospheric pressure being provided in the patient mask during the expiratory phase of respiration.

In other NIPPV modes the pressure can be made to vary in a complex manner throughout the respiratory cycle. For example, the pressure at the mask during inspiration or expiration can be varied through the period of treatment.

Typically, the ventilatory assistance for CPAP or NIPPV treatment is delivered to the patient by way of a nasal mask. Alternatively, a mouth mask or full face mask or nasal prongs can be used. In this specification any reference to a mask is to be understood as incorporating a reference to a nasal mask, mouth mask, full face mask or nasal prongs.

In this specification any reference to CPAP treatment is to be understood as embracing all of the above described forms of ventilatory treatment or assistance.

A CPAP apparatus broadly comprises a flow generator constituted by a continuous source of air or other breathable gas generally in the form of a blower or turbine driven by an electric motor. A hospital piped supply can also be used. The gas supply is connected to a conduit or tube, which in turn is connected to a patient mask

which incorporates, or has in close proximity, an exhaust to atmosphere for venting exhaled gases. The electric motor driving the blower is typically controlled by a servo-controller under the control of a microcontroller unit.

The noise produced by the electric motor and blower has three basic transmission paths to surrounding atmosphere. It is radiated from the apparatus housing, transmitted from the turbine outlet to be propagated along the conduit that connects the outlet the apparatus to the patient mask and transmitted from the turbine inlet to propagate along the gas inlet path (in the opposite direction of the gas flow) to the housing gas inlet and so to atmosphere. As CPAP apparatus are generally located in the same room of the patient being treated, generally within about 1 or 2 m of the patient, it is extremely desirable to minimise the noise the CPAP apparatus produces in order to maximise treatment compliance and also the comfort of the patient and/or any bed partner.

It is an object of the present invention to reduce the noise radiated from the apparatus housing.

SUMMARY OF THE INVENTION

Accordingly, in a first aspect, the present invention provides an apparatus for supplying breathable gas, the apparatus comprising:

a relatively rigid external housing;

at least one noise producing component internal the housing; and

a thin flexible enclosure substantially sealed around the noise producing components.

The enclosure preferably includes one or more apertures to allow breathable gas into and out of the noise producing component(s).

Preferably, the flexible enclosure is produced from plastics material. For example, the enclosure can be made from a polymer such as Cosmothene F221-1 or polyethylene.

The flexible enclosure preferably includes an opening adapted to allow passage of the internal component(s) into the interior of the flexible enclosure. The opening is desirably sealed by adhesive tape.

The noise producing components can include an electric motor, a blower or turbine, an inlet muffler or an outlet muffler. The electric motor drives the turbine. Atmospheric air is preferably drawn through the inlet muffler before entering the turbine and the resulting pressurised air preferably passes through the outlet muffler after leaving the turbine. The enclosure preferably includes a first aperture substantially sealed with respect to the exterior of the inlet of the inlet muffler and a second aperture substantially sealed with respect to the exterior of the outlet of the outlet muffler. The enclosure preferably also includes a third aperture for passage of

one or more wires for transmitting power or control signals to the electric motor and/or other electrical components, the third aperture being substantially sealed relative to the exterior of the wire(s).

According to a second aspect, the present invention provides a method of assembling an apparatus for supplying breathable gas according to the first aspect of the invention, the method comprising the steps of:

assembling the noise producing component(s) into a sub-assembly;

placing the sub-assembly into the interior of the thin flexible enclosure through an opening therein;

substantially sealing the opening; and

placing the sub-assembly and flexible enclosure within the external housing.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 is a schematic view of an embodiment of an apparatus first system for supplying breathable gas according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figs. 1 shows an apparatus 1 for supplying breathable gas. More specifically, the apparatus 1 is adapted for use a CPAP apparatus. The apparatus 1 comprises a relatively rigid external housing 2 which is generally in the form of upper and lower housing halves produced from a plastics material. Internal the housing 2 there is several components capable of producing noise. In the embodiment shown in Fig. 1 these components include an inlet muffler 3, a blower 4, an electric motor (not shown), a conduit 5 and an outlet muffler 6.

The inlet muffler 3 has an inlet 11 open to atmosphere and an outlet (not shown) connected to the inlet (not shown) of the blower 4. The blower 4 has an outlet 12 connected to the inlet 13 of the conduit 5. The conduit 5 has an outlet 14 connected to the inlet 15 of the outlet muffler 6. The outlet muffler 6 also includes an outlet 7 which is connected to a conduit or tube (not shown) which communicates the pressurised gas produced by the blower 4 to a patient mask (not shown).

Air from atmosphere drawn into the inlet muffler 3 is indicated by arrow 16. Pressurised air leaving the outlet muffler 6 is indicated by arrow 17.

The apparatus 1 also includes a thin flexible enclosure indicated by dashed lines 8. The enclosure 8 extends around the noise producing components 3, 4, 5 and 6 and is substantially sealed with respect to same. The enclosure 8 includes a first aperture 18 sealed with respect to the exterior of the inlet 11 of the inlet muffler 3, a second aperture 19 sealed with respect to the exterior of the outlet 17 of the outlet muffler 6 and a third aperture 20 sealed with respect to the exterior of wires 21 used to communicate power and/or control signals to the motor and other electrical

components. In this way, the flexible enclosure 8 effectively isolates the exterior of the components 3, 4, 5 and 6 from their surroundings but still allows passage of air into and out of those components.

The enclosure 8 is preferably made from a plastics material for example a polymer such as Cosmothene F221-1 or polyethylene. The enclosure 8 is generally of bag like construction with an opening at one end that leads to an interior 9.

To assemble the apparatus 1, the components 3, 4, 5 and 6 are all assembled together into a sub-assembly and passed through the opening into the interior 9 of the enclosure 8. The apertures 18, 19, 20 in the enclosure 8 are located in sealed relationship with respect to the exterior of the inlet 11, the outlet 7 and the wires 21 respectively. The opening in the enclosure 8 is then preferably sealed by adhesive tape. Other adhesives or heat sealing can also be used to seal the opening in the enclosure 8. In this connection, it will be appreciated that it is not imperative to achieve a completely air tight or hermetic seal between the enclosure 8 and the components 3, 4, 5 and 6 that the enclosure 8 surrounds. The sub-assembly of noise producing components and enclosure is then placed between the two halves with the housing 2 which are then joined in the known manner to complete the apparatus 1.

The interior 9 of the enclosure 8 can be left substantially empty or can be filled with foam or bubble wrap or the like.

Testing of two similar prototype CPAP apparatus (denoted 1. and 2.) with and without the flexible enclosure 8 revealed the following average dBA noise levels from measurements taken at the front, back, left and right side of the housing 2 with both the CPAP apparatus being operated to produce gas flow at a pressure of 10 cm H_2O.

CPAP Apparatus	Without enclosure (dBA)	With enclosure (dBA)
1.	34.2	32.4
2.	34.5	32.0

Accordingly, as these results show, the invention provides a very simple and inexpensive way of reducing the noise radiated from the housing by approximately 2 dBA.

Other advantages include the ease of installation of the flexible enclosure, and corresponding ease of replacement. The apparatus is also easier to sterilise, as the components of the apparatus through which air is drawn are effectively isolated from other components, such as electrical circuitry.